Micro Elastofluidics for Tuneable Droplet Splitting

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S-1 Numerical modelling of microfluidic device stretching

The numerical modelling of stretched microfluidic devices was conducted using COMSOL

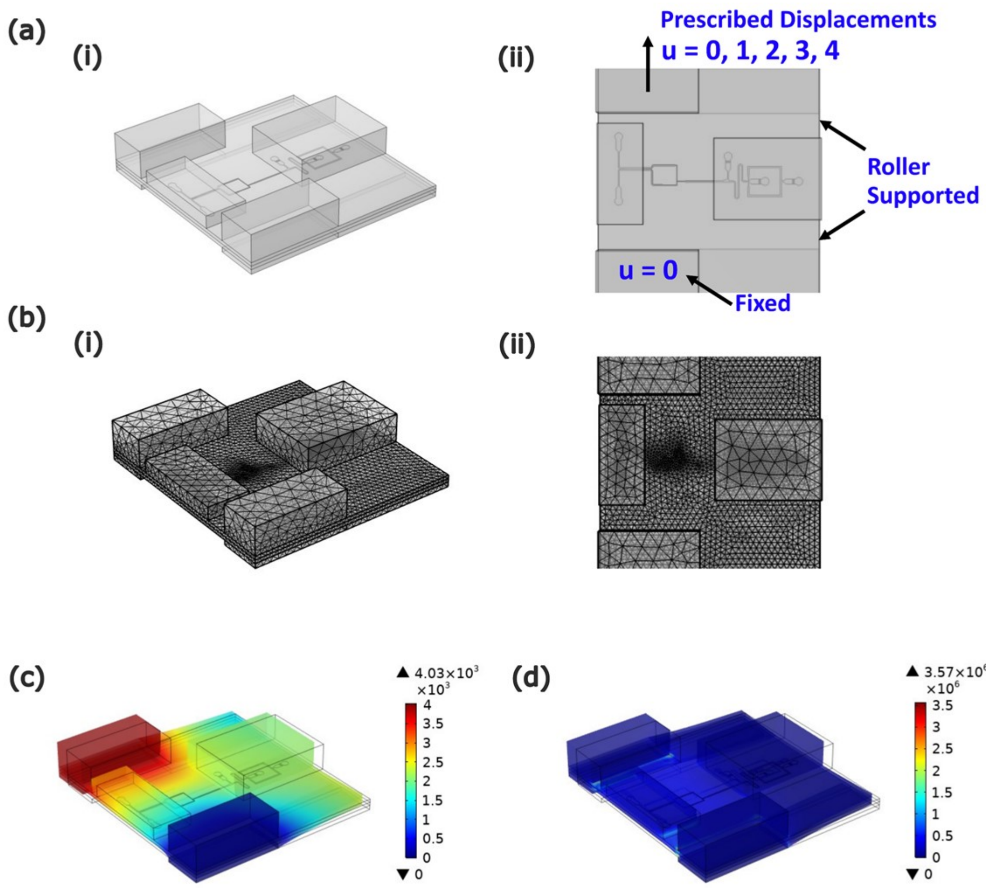

Fig. S1. Numerical simulation: (a) Simulated geometry and boundary conditions; (b) User-controlled mesh; (c) Displacement analysis; (d) Stress analysis

Multiphysics 5.6. A 3D space dimension with solid mechanics physics and a stationary study were selected. The device geometry shown in **Fig. S1a(i)** was designed during the preprocessing stage within the COMSOL model builder environment using the basic geometry tools available. Then, the boundary conditions shown in **Fig. S1(ii)** were applied to the geometry. The device is fixed at one end and varies the displacement from 0 to 4 mm, which resembles stretching the flexible device at 1-mm steps. After setting up the boundary conditions, a user-defined PDMS material was assigned to the model. Here, we assumed that the PDMS behaves in the linear strain region as we only stretch the material up to ~16% linear strain, and most hyperplastic material models for 10:1 PDMS approximately follow a linear variation in this strain range. [1-3] A user-controlled mesh **Fig. S1b** was generated to discretise the model geometry for conducting the finite element analysis. Here, the geometry was discretised to 182,620 mesh elements with a minimum element quality of 0.165 and an average element quality of 0.629. Finally, a stationary study was set to combine with a parametric sweep to introduce prescribed displacement in each iteration of the numerical model. Processing time took 8 min 45s for a desktop computer with Intel® Xeon® Silver 4114 20 Core CPU at 2.20 GHz clock speed and 64-bit Windows 10 operating system with 32.0 GB RAM. During post-processing of the simulated data, we used edge probe tools to evaluate displacements with stretching at specific locations on the microchannel arrangement to account for the deformation of microchannels at interested sections along the microfluidic channels. The displacement/deformation **Fig. S1c, d** was obtained using 3D plot groups.

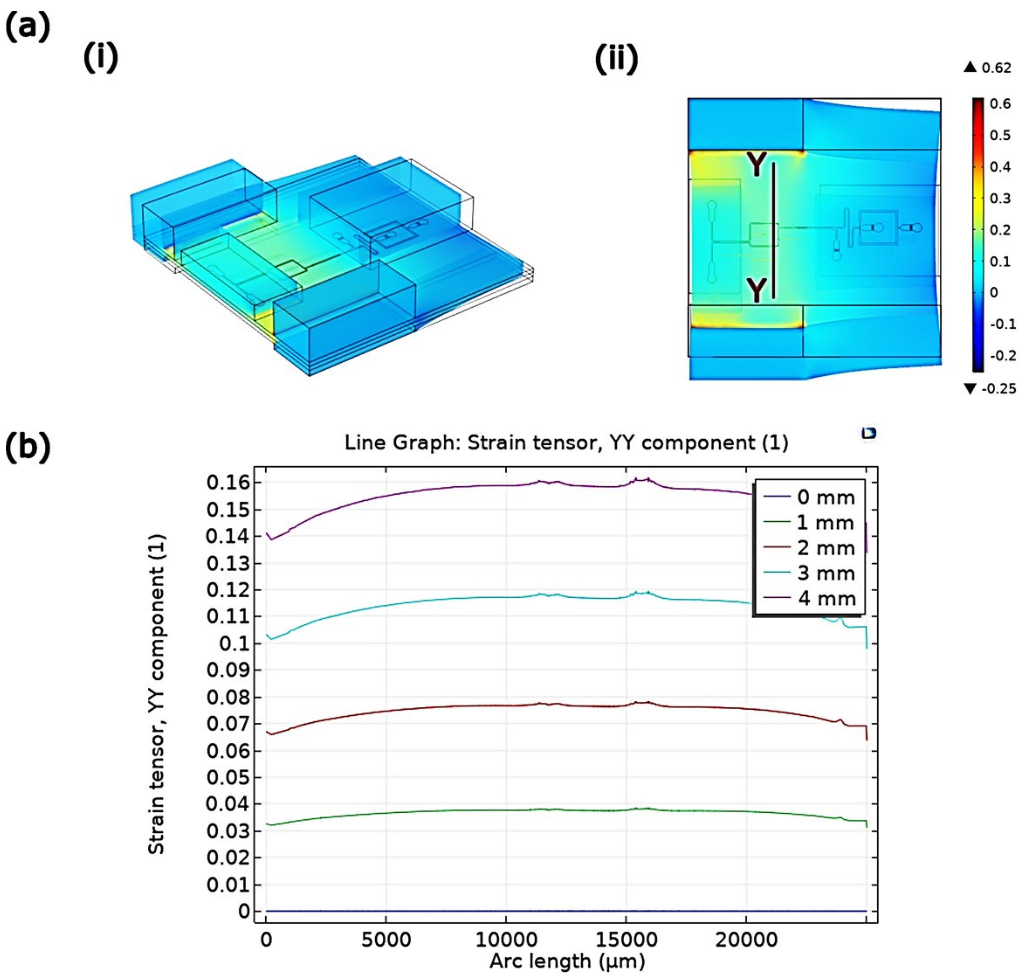

Fig. S2. Simulation of device strain: (a) (i) 3D plot of strain variation in the device, (ii) location of the cut-line used to analyse directional strain; (b) Device strain along the Y-Y direction under different elongations.

In addition, we analysed strain variation along the lateral direction across the flexible layer, **Fig. S2a(i)**. The strain variation was plotted along the line Y-Y (**Fig. S1a(ii))** and along the length of the line **(Fig. S2b)**. From the graph, it can be concluded that the device strain is uniform near the splitting loop, resulting in uniform stretching.

References

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2. T. K. Kim, J. K. Kim and O. C. Jeong, *Microelectronic Engineering*, 2011, **88**, 1982-1985.
3. Y. Huang and N.-T. Nguyen, *Biomedical microdevices*, 2013, **15**, 1043-1054.